The VHE anomaly in blazar spectra and related phenomena

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Observations made with imaging Cherenkov telescopes in the very high energy (VHE, E>100 *GeV*) region allow to test extragalactic gamma-ray propagation models. Most of the recent research focused on the study of the γγ→e^{+}e^{−} absorption process. Some works found that the observed intensity in the optical depth region τ_{γγ}>2 is too high to be explained in the conventional framework of the “absorption-only model” that takes into account only absorption of primary photons and their adiabatic losses.

This anomaly was interpreted as an evidence for the gamma – axion-like particle (γ→ALP) oscillations. However, another signature of γ-ALP mixing --- the irregularity at comparatively low energies --- was not found (M. Ajello et al. (Fermi-LAT Collaboration), Phys. Rev. Lett., **116**, 161101 (2016), preprint astro-ph/1603.06978), and the scenario in which ALPs can modify the γ-ray opacity of the Universe was strongly constrained.

In this work we consider other explanations of the anomaly, that do not require any new physics, namely, the models that include secondary (cascade) particles initiated by primary gamma-rays or protons. There exist many indications that the cascade component indeed contributes to the observed spectrum of some blazars at energies $E < 300$ *GeV*. We show that the cascade component may induce significant background for ALP searches in the optically thick region of the spectrum, both for the case of primary gamma-rays and primary nuclei.

Therefore, experiments with high energy threshold (~1 *TeV* and above) appear to be insufficient for the γ→ALP process search; the observations at these energies must be supported by independent studies at relatively low energy (E~100 *GeV*). Finally, we show that the CTA array, which will have comparatively low energy threshold (E<50 *GeV*) and broadband sensitivity (up to tens of *TeV*) will likely allow to indicate the physical mechanism responsible for the anomaly.

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